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ABSTRACT

This report is intended to provide advice to Ontario school staffs, school boards, and the Ministry of Education on (1) the effects of using computers in schools, (2) criteria for selecting courseware and hardware, (3) subjects most effectively approached with computers, and (4) priorities for future courseware development. Pilot projects for the following five pilot schools are presented under the subheadings of Organization and Human Involvement, Equipment, Curriculum Uses, and Issues and Concerns: (1) Dundalk and Proton Community School (English language 1-8), (2) Ecole St. Anne (French language 1-8), (3) North Addington Education Centre (English language K-12), (4) Ecole Secondaire de la Lalle (French language 9-13), and (5) Danforth Technical School (English language 9-13). The report's conclusions and recommendations advise additional research in such areas as the potentially adverse effect of computer use on students' mastery of basic skills. Findings further indicate that although students and teachers were generally enthusiastic about using computers they lamented the lack of time with the equipment and the lack of sufficient hardward and suitable software (particularly in French language schools). Teachers emphasized the need for more time to investigate the computer's applicability to existing curricula and requested guidelines for computer implementation strategies in the classroom. (JBM)

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Computers in Ontario Education: Report on the Pilot School Projects

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Executive Summary

The terms of reference of the pilot schools project were to provide advice to school staffs, school boards, and the Ministry of Education with regard to:

1. the effects on students, teachers, and the community of the use of computers in schools;
2. criteria for quality courseware and hardware;
3. topics and subjects that lend themselves to the most effective use of computers;
4. priorities for future courseware development.

The five pilot schools were selected to provide widely different experiences from across the province. Two of them are French-language schools (one elementary and one secondary). One school offers a program from Kindergarten to Grade 13. Two offer only elementary programs and two offer only secondary programs. The schools range in size from 325 students and a teaching staff of 12 to 1400 students and a teaching staff of 90.

In some respects the experiences of the five schools are very different, representing different concerns and different approaches. For example, the three schools that offer secondary programs use computers both in computer-assisted instruction and in computer studies courses, while the two schools that offer only elementary programs use computers for LOGO, word processing, and drill and practice. In some of the schools, computer hardware is concentrated in a computer room or lab, while in others, the equipment is placed in individual classrooms throughout the school.

In many respects, however, the experiences of all of the schools uncovered common concerns that are reflected throughout this report and in a concentrated way in the conclusions and recommendations at the end of the report.

For example, a major stumbling block to the use of computers in the classroom in all of the schools was the lack of Canadian or suitable software. This was a special problem for the French-language schools, since there is a dearth of software in the French language. All of the schools reported that most of the existing software is often not sufficiently tied to the curriculum and is not organized in sequential lesson units.

A number of questions were raised regarding the effect of the use of computers in the classroom on the education of students. One question often raised was whether the use of computers might adversely affect students' mastery of the basic skills of reading, writing, and computation. Such concerns are reflected in this report's conclusions and recommendations. In most cases, some further action on the part of the ministry may be advisable.

In general, students were initially enthusiastic about the use of computers in the classroom. Their main complaints were that they did not have enough time with the equipment. Teachers were also enthusiastic about using computers in their classrooms. They, too, lamented the lack of sufficient hardware and software to capitalize satisfactorily on this valuable learning tool.

Several teachers also indicated there was a need to allocate more teacher time to investigating and developing the integration of computer resources with existing curricula. It was also stated by many teachers that there was a critical need for teacher resource materials and guidelines to direct implementation strategies for using computers in the classroom.

It is hoped that the questions raised by the pilot projects and reflected in this report will enable the ministry to take steps to improve the use of computers in schools. It is also hoped that the experiences of the pilot

schools will serve as examples for other schools that are embarking on the use of computers in their classrooms and will facilitate their success in this regard.

This report provides the status of each pilot project under the following headings:

- Description of the School
- Organization and Human Involvement
- Equipment
- Curriculum Uses
- Issues and Concerns

The last six pages are devoted to conclusions and recommendations.

Dundalk and Proton Community Public School

Dundalk and Proton Community Public School is a twinned school located in two buildings 1 km apart in Dundalk, Ontario, in the Grey County Board of Education. It offers a program from Kindergarten to Grade 8 to 427 students (234 boys, 193 girls). The school has a staff of 27 teachers.

Organization and Human Involvement

The pilot project at Dundalk and Proton was well supported by board administrators, and it involved parents and members of the community as well as teachers and students. Administrators facilitated the provision of training sessions for teachers and parents and such organizational tasks as those related to scheduling and the sharing of equipment. The board provided six night courses in which three of the teachers became involved and two in-school sessions in which all of teachers were involved.

Teachers were responsible for scheduling students' use of the computers and were also involved in professional development activities in the computer field. Of the school's 27 teachers, only one had expertise in this area at the start of the project. Today, as a result of hands-on experience made possible by training sessions and the ready availability of equipment on loan (overnight, on weekends, over the summer), all but one of the teachers are able to use the school's computers. Twenty-five of these teachers have been involved in teaching classes and various methods of utilizing computers; two have conducted remedial work with groups of students; and 20 have been involved in evaluating materials.

A steering committee for the pilot project was set up, with membership comprised of representatives from OISE, the University of Western Ontario, the Ministry of Education's western regional office, the principal (who was the

chairman), a board trustee, a curriculum consultant for the board, the board superintendent, two parents, and three students.

Thirty-six parents and others were involved in three computer-awareness courses (how to load, run, and use a computer program). Five 16-hour continuing education courses in basic programming were offered by three of the school's instructors to 65 people between 1981 and 1983. Computers were on display and functioning at such school events as parents' nights and Kindergarten registrations and during Education Week. Presentations were also made to such groups as service clubs and women's institutes. These community-sharing activities led to a very high interest in computers in the area (there continues to be a high demand for the continuing education course) and successfully alleviated most parental concerns regarding the use of computers in education.

About 350 of the 427 students were involved in the pilot project. The main use was in Grades 1-8, with the least usage in Kindergarten. On the average, students were reported to have spent 36 minutes per week on the computer. The students also participated in the program's organization. Others participated in the evaluation of software programs and provided valuable input regarding both the use of computers and the suitability of the programs used.

Student reaction to the use of computers was very positive. The availability of immediate feedback in the learning process and the enjoyment experienced in programming were commonly cited as advantages. On the negative side, the insufficient number of computers in the school, the time required to load from tapes, and the problems experienced in programming (e.g., pedagogical, technical) seemed to be the main sources of frustration for students. Some expressed concern about the expense involved in using computers.

The school's secretary was very much involved in program support activities. Her tasks included taking courses related to the use of computers in schools, helping plan training activities for parents and teachers, and taping, cataloguing, and previewing programs.

As a result of the pilot project, Dundalk and Proton became a showcase for the school use of computers. Its doors were always open to in-county and out-of-county educational personnel, and its staff became involved in providing professional development activities to about 90 teachers in the county. They will be involved in two upcoming conferences as well.

Equipment

The hardware used in the project included:

- 18 Commodore PETs;
- 3 Commodore Vic 20s;
- 2 Commodore 64s;
- 2 4040 disk drives, and cassette tapes;
- 2 4022 printers;
- cassette tape recorders.

The computers were satisfactorily scheduled on a sign-out basis, with a home room used as a base. Each computer was placed on an A-V cart for ease of movement. Teachers preferred to have at least one computer in each classroom full time. Provisions were made for them to book additional units for periods of time.

There were no major problems experienced with the hardware. In general, it was found that for classroom use, disk drives were better than cassette drives because of their greater speed. It was also reported that the 16K computers did not have sufficient memory for many of the programs being developed.

It was recommended that computers with at least 32K of memory be purchased in the future.

Some problems were experienced with software. Taping and cataloguing were found to be a full-time job -- too time-consuming for resource-centre teachers. This was compounded by the procedures required to administer the checking out and returning of programs. While the loan of an additional secretary from the board for a three-month period helped, this was seen as a stopgap measure only. It was suggested that multiple copies of programs should be available or that the schools obtain permission to duplicate programs. As well, it was suggested that the ministry consider establishing a workable, provincial system for cataloguing and indexing software and courseware.

There were many problems with the quality of software programs. Spelling and grammatical errors - including the random use of upper- and lower-case letters - were common. In many cases, programs were not compatible with the instructional level at which they were used. These problems encouraged teachers and some students to create their own programs. Some teacher and student programs were also created for record-keeping uses (attendance, student directory) in the school's office.

Curriculum Uses

Computers were used mainly in the areas of language and mathematics. Limited use was also reported in environmental studies, music, history, geography, art, French, science, and in the library. High usage was reported in drill and practice for language and mathematical skills. Small groups from Grades 1-5 were withdrawn from the regular classroom for remedial drill and practice in mathematics.

In addition, programming classes were provided for students in Grades 4-8, with each class having a 30-40 minute period scheduled each week.

Computers were useful in motivating visually or kinesthetically oriented learners (especially where drill work was involved and in extending students' attention span. Computers were found least useful in history and geography, music, and environmental studies because of the lack of suitable lessonware. In fact, a major stumbling block to the use of the computers in the classroom was the lack of software programs. It was also found that existing programs are often not sufficiently tied to the curriculum and are not organized in sequential lesson units. A need was expressed for programs that teach thinking and logic skills, since it is these skills that will ultimately equip students to use the computer as an effective tool.

Issues and Concerns

In addition to the concerns reflected above, the following concerns were raised:

-- A system is required to measure the effectiveness of using computers in the classroom.

-- Will the general literacy of students suffer as a result of using computers in the classroom? It is important that the "basics" do not get overlooked. (This is a perceived concern of parents as well.)

-- The quality of programs in the public domain are inadequate.

-- The availability of computers and of programs in quantity are limiting factors.

-- Teachers must be capable of modifying existing lessonware.

-- The ministry should provide an authorized list of programs that have been developed to pre-set standards and that are compatible with ministry guidelines.

-- In terms of the pilot project, three problems were noted: the time required for taping and cataloguing programs; the lack of funding for the purchase of software; and the need to move computers between two buildings that are 1 km apart.

-- Additional funds should be available for other supplies (i.e., tapes, disk, and paper).

Ecole Ste Anne/French-Language Elementary Separate School

Ecole Ste Anne is a French-language school located in Ottawa in the Ottawa Roman Catholic Separate School Board. It offers a program from Kindergarten to Grade 8 to 325 students and has a staff of 12 teachers.

Organization and Human Involvement

A steering committee, chaired by an education officer from the ministry's regional office, was established for the pilot project. The project was strongly supported by the ministry's consultant in French-language services; by the board's superintendent of curriculum, who facilitated the project's budgetary and staffing needs; by a trustee; and by additional personnel from the board's curriculum department, who provided ongoing assistance ranging from physical (classroom) arrangements to providing teachers with pedagogical support.

The principal acted as the secretary of the steering committee and provided continuous administrative support for the project. He arranged for the release of teachers during school hours so that they could pursue project-related activities, kept parents informed of the project's progress, provided access to the project for interested outside parties (e.g., other boards, news media), arranged the school's timetable so that different grade levels would have equal access to computer resources, and provided administrative support for the physical facilities.

The teachers strongly supported the project. Four teachers attended a number of in-service activities prior to and during the life of the project and were involved in developing evaluation criteria. Two of these teachers were also members of the steering committee. The interest and involvement of these four teachers spread to the rest of the school staff so that a total of 10 teachers are now teaching classes using the school's computer resources.

The board continues to provide in-service computer education for the teachers involved in the pilot project (approximately 10 hours per teacher), as well as for other interested teachers. Workshops have also been organized for other principals in the board.

On the whole, all of the teachers involved are participating effectively, although some require more assistance and follow-up than others. There are problems with the computer literacy of teachers who have not been involved in the project. It is felt that the success of future computer projects similar to the pilot project depends on developing at the outset positive attitudes among administrators and teachers. To accomplish this, boards and faculties of education must offer teachers more in-service programs that meet the specific computer literacy needs, especially with respect to classroom processes and pedagogical approaches.

The following are some of the concerns raised by the teachers:

-- Can students' enthusiasm be maintained over time?

-- Will quality software be developed to support academic programs (e.g., science, French, mathematics, history)?

-- How can specialized software, such as LOGO, be best utilized in order to provide sufficient scope for computer-based learning activities?

-- Is there sufficient in-service training for teachers?

-- How can software be integrated into curriculum?

-- Is the computer-student ratio adequate? What effect does this ratio have on classroom management?

It was noted that the assignment of a half-time consultant to the project was crucial to its success. There is thus a need for additional human resources when computer activities are initiated. As well, in-service training for teachers should be a prime concern.

Parents were invited to attend two evening in-service sessions offered at the school and from the beginning of the project, were represented on the steering committee. The enthusiasm thus generated was considerable. Some parents visited the school's computer room and some went so far as to purchase home computers. The support of the local media was also useful in giving the project a high profile in the community. The only concern raised by parents related to the possible health hazards presented by computer equipment.

Every student in the school had access to the computer as a learning tool, although some were more involved than others. Of the 275 students who were most involved in the project, 135 were male and 140 were female. The greatest use of computers was in Grades 2-4 and in Grade 7. Computers were used to a lesser extent in Grades 1,5,6, and 8 and were used least in Kindergarten. The average time spent by each student on the computer varied from one hour per day to one hour per week.

Students' response was basically positive. Students found computer-related activities challenging and motivating, and they enjoyed the individualized learning that computers make possible. Their main complaints arose from not having sufficient time with the equipment, not being able to work alone on the computers (they did not like working in groups of two or three per computer), and from not being able to try courseware other than LOGO in the Junior and Intermediate divisions. It is suggested that more challenging software is required and that students need more time to satisfactorily explore their own ideas using computers.

The board sponsored two computer-related summer projects through the Experience '81 and '82 programs. The software developed through these projects was made available to the pilot project and were evaluated after classroom testing. As a result, some of this software is now being improved.

The project also received strong support from the faculty of education at Ottawa University. Two faculty members served on the steering committee. As well, two Ministry of Education students involved with a university project designed to investigate ways of using computers with gifted students conducted their clinical studies at Ste Anne's, working with a group of students selected by the principal.

LOGO Canada Systems Inc. made available to the project a prototype copy of the French version of its Apple LOGO and supporting documentation. Ongoing communication between this firm and the pilot project's participants was most helpful in using LOGO as a basis for the project.

Equipment

The hardware used in the pilot project included:

- 11 64K Apple IIs;
- 11 disk drives;
- 11 colour monitors;
- 1 Epson MX100 printer;
- 1 Epson MX80 printer;
- 1 graphics tablet.

During the pilot project there was no damage to the equipment as a result of vandalism because of controlled access to the equipment and close staff supervision. It is suggested however, that serious consideration be given to installing a security system. To avoid the considerable time losses experienced during the pilot project for the

repair and maintenance of the equipment, it is also suggested that the board obtain a firm service contract guaranteeing a maximum two-day turnaround time with a provision for units on loan. Trouble-shooting and minor repairs should be a board rather than a teacher responsibility.

Student access to the equipment was found less than effective when the student-computer ratio exceeded 2:1. It was found that strict timetabling of the computer room ensured schoolwide equality of access to the equipment, but a student-computer ratio of 2:1 should be considered an absolute maximum. The use of additional human resources and team teaching should also be considered.

The computer room was a converted classroom. A horseshoe arrangement was found preferable for elementary classrooms. This allowed teachers easier access to all students and prevented students from being distracted. It was suggested that furniture should be designed and custom-made to suit children. Also, the screens should have a minimum diagonal dimension of 35 cm, and computers should be placed at some distance from chalkboards and radiators and positioned so as to avoid glare from windows.

It was suggested that an orderly, central storage facility for software should be provided within the computer room and that access to it be controlled; that back-up copies of software be available wherever possible; that teachers be made aware of the different possibilities and criteria for good software; and that a classification scheme be devised for indexing and cataloguing software.

Some software was developed by the board's resource person in response to specific needs identified by teachers. As well, a number of programs were developed through the Experience '81 and '82 summer projects noted above. However, the lack of quality software remains a major concern.

Curriculum Uses

The single most common use of the computer in the pilot project was the use of LOGO as a learning tool throughout Grades 1-8. Other software was available in limited quantity and quality, but teachers felt uneasy about integrating such software into the curriculum. Intensive use of computer resources were noted in numeration and estimation, in geometry, and in the development of psychomotor skills, thinking skills, visual perception, and spatial relationships. Computers were used to a lesser extent to develop oral and written communication.

Computers were found particularly useful in increasing students' attention span, especially those in the Primary Division; in providing opportunities for creativity and an individual approach to problem-solving; and in developing logical patterns of thought and stimulating organizational behaviour. The main problems this project experienced were:

- the lack of quality software that can challenge students and develop their creativity;
- the high student-computer ratio;
- an overwhelming teacher workload, which prevented teachers from effectively addressing the integration of computer resources into the curriculum;
- the need to develop effective implementation strategies.

It was also noted that for certain students, drill and practice programs are not very effective.

Issues and Concerns

There were no concerns expressed in addition to those noted above.

North Addington Education Centre

The North Addington Education Centre is located in Cloyne, Ontario, in the Lennox & Addington County Board of Education. It offers a program from Kindergarten to Grade 13 to 543 students, of which 293 (143 male, 150 female) are elementary, 242 (94 male, 148 female) are secondary, and eight (seven male, one female) are students with learning disabilities. The school has a staff of 35 teachers.

Organization and Human Involvement

An advisory committee to the pilot project was established at the outset. It consisted of the school's principal, who acted as its secretary; a trustee; the board's director of education; a representative of the ministry's regional office, who acted as the committee's chairperson; three teachers; two parents; four students; and a representative of the faculty of education at Queen's University.

The board administration was very supportive, providing flexibility in the school's budgeting to allow for software, hardware, and special needs of the pilot project. The board also established an ad hoc computer committee to evaluate and standardize hardware purchases across the county. In turn, the school administration placed a high priority on the use of computers in all aspects of the school; encouraged teachers, parents, and students to become involved with the project; supported non-traditional, creative uses of the computer; provided supply teachers so that teachers could attend workshops and meetings; and timetabled elementary classes into the computer room as well as provided them with computers that circulated among individual classrooms. Throughout, the ministry's regional office was highly supportive.

At the outset of the project, three or four of the 35

teachers were comfortable using computers. Twelve are using computers today, 10 of whom teach full classes and all of whom use computer resources to teach groups of students. The board provided minimal in-service computer education; this usually consisted of an hour or two of demonstration with some hands-on activity. However, 15 teachers are or have been enrolled in a one-half credit evening course in computer science given at the school; three teachers are enrolled in TVOntario's "Computer Academy" (the school has purchased the tapes); one teacher is enrolled in the Computers in the Classroom ministry course at Queen's University; and five elementary teachers are involved in the LOGO research project at the faculty of education at Queen's University to offer Computers in the Classroom, Part I, at the school in 1983-84.

Although most teachers recognize the need to adapt to the new technology and are involved in some way with the co-operative use of computers in the classroom, many are uncertain about computers and some are unwilling to put in the time required to become familiar and comfortable with computer hardware and software. This could become a problem when students who have developed computer literacy skills in one grade move on to another class where opportunities to use computers do not exist. It is suggested that the administration encourage the use of computers by providing time and financial support for teachers to continue in-service training before, during, and after school.

Parent interest has been high. The parent advisory committee attended an evening program that outlined the school's computer project. Many parents have attended computer science and word-processing programs at night school, and parent volunteers have assisted with the classroom use of computers. Members of the community have been involved through an open house, newsletter and newspaper articles, and local TV shows. No negative comments on the pilot project have been received from

parents, although questions have been raised regarding how computers are being used to teach basic skills, whether the schools have sufficient computers for this purpose, and whether students across the grade levels obtain sufficient and equal time on the computer.

All of the 543 students were involved in the pilot project. The greatest usage of computers reported was in Kindergarten, Grades 1-3 and 8, and with students having learning disabilities. The least usage was in Grades 4, 6-7, 9, and 13, with an intermediate level of usage in the other grades. The average time each student spent on the computer varied from 0-3 hours per day and 0-15 hours per week. Secondary computer sciences classes (Grades 10-12) were oversubscribed during the past two years. Primary students had access to the computers twice a week, and Grade 8 students used the computer room daily. Five to six students were involved in Experience '81 and Experience '82 projects that involved cataloguing and evaluating software and creating unique education programs specifically requested by teachers. Many of the students involved in the latter activity assisted the teachers in using their software during the 1982-83 school year.

Students found that they were motivated by the computer. The immediate feedback allowed them to proceed at their own rates, thus making individualized programs a reality. However, they were frustrated by the lack of equipment and software and insufficient time on the machines. Some problems were reported with temperamental disk systems when used by Primary children.

Equipment

The hardware used in the project included:

- 17 64K Apple II+ microcomputers and disk drives;
- 3 Epson printers (dot matrix);
- 1 Lanpar Dec Writer;

- 1 graphics tablet;
- 1 DC Hayes micro modem;
- 3 80-character boards.

The main problem has been that the demand for the equipment exceeds the time available. Elementary students and teachers are no longer satisfied with one computer at the back of the room. They now see a need for both a classroom computer and easy access to a computer lab. It is suggested that:

- two interconnected rooms, each with 15 computers, be set up;
- a computer be placed in each classroom;
- provision be made for those who are less "aggressive" in making their computer needs known;
- access to the equipment be as extensive as possible (since students will stay as long as the room is open); and,
- a non-teacher supervisor be hired for off-hour supervision and control of the room.

Little vandalism was reported. It was found that students were very protective of the equipment since everyone lost in a tangible way when a machine was inoperative.

Some problems were experienced with the lab. It is not centrally located, thus making access difficult for elementary classes. The furniture is adult size and difficult for small children to use. Some adaptation to a limited supply of electrical outlets is necessary. It is suggested that a perimeter lab be set up with many electrical outlets available. Also, the ministry should commission a research study on how to convert a classroom into a computer work area or lab, taking into account physical layout, furnishings, lighting etc.

Although teachers were discouraged from taking equipment home because of the possibility of damage, arrangements were made for them to have access to the equipment during evenings, holidays, and weekends by being able to check out a key to both the school and the computer room.

Problems were experienced with the variable quality of the available software and by the fact that most of it is made in the United States. The evaluation of software also caused problems, because different evaluators look for different things in any given program. It is suggested that each evaluator record his or her reaction so that others can see the variety of opinions. These data should be collected through a word-processing or data-management system.

The indexing and cataloguing of software also caused problems. It is suggested that a Dewey decimal system standard be established for cataloguing each program on a given disk, rather than cataloguing a disk as a whole. It is also suggested that the ministry establish a computerized data-management system so that software can be managed on a large scale, with the Universal Product code symbols centrally generated.

Disk storage boxes and envelopes were found to be too weak. Problems were also found with the distribution of software. The need to lock software storage areas for security reasons must be balanced by the need for availability. As well, some legal means of copying disks must be found in order to improve availability and back-up copies.

Curriculum Uses

Computers were used in computer courses (computer science, data processing, informatics, word processing), as a learning aid for teaching number skills, alphabet skills,

problem solving, and creative writing, (in language arts, LOGO, mathematics programs) and in special education (drill and practice, skill-building, motivation). The highest use of computers was reported in language arts, mathematics, computer studies, and business. They had moderate use in the sciences and social sciences, and low use in guidance, art, geography, family studies, technical subjects, environmental science, music, and modern languages. That most software is of American origin was a special problem in the social sciences, where students had to work with U.S. applications and history.

Issues and Concerns

In addition to the concerns reflected above, the following issues were raised:

-- More equipment and Canadian software are required.

-- The expense of computer equipment limits its availability.

-- A clear-cut curriculum policy on the appropriateness of the use of computers within existing programs is needed.

-- A regular maintenance program should be provided on a boardwide basis, either through an outside contract or through the training of board personnel.

-- Because trustees are not sufficiently familiar with the use of computers in schools, they do not see the need for budget support. More information and advice should be supplied to them by the ministry and by trustee organizations.

-- There is a problem with the continuity of computer use from one grade to another and from one subject to another.

-- There is a need to teach typing skills at an early age. At what point should they be taught and by what method should they be taught?

-- Since more than one teacher is required when computers are introduced into a class, more teacher assistance should be provided.

-- Increased equipment is necessary in order to ensure equality of student access to computers.

-- Traditional teaching methods should be adapted to the needs of our electronic age.

Ecole Secondaire De La Salle/French-Language Secondary School

Ecole Secondaire De La Salle is located in Ottawa in the Ottawa Board of Education. It offers a program in French from Grades 9 to 13. The school has 650 students and a staff of 55 teachers.

Organization and Human Involvement

An assistant superintendent was given the task of administering the pilot project for the board. Four teachers offered introductory programming and informatics courses. They were also responsible for overseeing extra-curricular computer activities within the school. The number of teachers with computer expertise increased from three at the start of the project to 21 today. In-service computer education for teachers included a one-week Introduction to Microcomputers course, a continuing education course in the evenings, an eleven-session technological course at night school, and many professional activity workshops. This amounted to an average of 20 hours of in-service training per teacher.

No negative reactions have been experienced from the teachers involved in the program. However, teachers have enunciated some concerns, including the following: an overload of work; a lack of pedagogical materials in French; the need for a technician; and the need to make equipment available to students outside of school hours.

Parents were invited to take part in the pilot project's steering committee and contributed their suggestions. The school has an open-door policy during the day, and parents have also been able to visit the school in the evenings. In addition, there have been numerous newsletters and newspaper articles and local radio and television programs on the project.

The response to the pilot project by both parents and the community was enthusiastic. The only concern expressed was whether the use of computers endangers computation, writing, and other basic skills.

More than 300 (150 males, 150 females) students were involved in the pilot project. The highest use of computer resources was reported in Grades 10 and 11, less in Grade 12, and the lowest in Grades 9 and 13. Each student spent an average of 30 minutes per day on the computer. Some of the students also participated in a computer club, and some helped teachers develop courseware.

Students enjoyed the challenge posed by computers, the immediate feedback that they provided, and the effort that their use saved. However, students complained about errors in the software, insufficient explanations in courseware, and defects in the hardware. The software must be improved and the hardware must become more reliable.

Equipment

The hardware used in the pilot project included:

- 18 Commodore PET 4032s;
- 2 Commodore PET 2001s;
- 3 SUPERPETs;
- 1 APPLE II, with 2 disk drives;
- 2 Cybernex modems;
- 3 Commodore 4040 disk drives;
- 2 Commodore 8050 drives;
- 1 Epson MX80 printer;
- 2 Commodore 2022 printers;
- 1 CENTRONICS printer;
- 2 AES word processors with 1 printer;
- 3 Mupet networks;
- 18 cassette tape recorders.

It was found that a second computer centre would be

necessary in order to achieve equality in students' access to equipment. The only problem experienced with the upkeep of hardware was the need for a local Mupet distributor to handle repairs and maintenance. The networking system was often defective, requiring immediate attention that could not be obtained locally; thus the system was down for weeks at a time. The only other problem reported was the slowness and inefficiency of using cassette tape recorders. Disk drives are much faster and thus more efficient.

The main problem reported with software was the complete lack of courseware in French. Some software was created by teachers and students to satisfy specific needs that arose during the course of the project.

Curriculum Uses

The main uses of the school's computers were in introductory courses in Grade 10, computer courses in Grades 11 and 12, computer-assisted instruction in the study of French, and in the exploration of career planning as part of the school's guidance program. High use was reported in introductory courses, programming, word processing, the teaching of French, and vocational guidance. Some use was also reported in electronics courses and, to a lesser extent, in special education, mathematics and accounting.

Issues and Concerns

The main problems encountered were the lack of software available in the French language, the lack of compatibility among the hardware used, and the low pedagogical quality of the programs.

Danforth Technical School/Secondary School

Danforth Technical School is located in Toronto in the Board of Education for the City of Toronto. It offers a program from Grades 9 to 13 to about 1400 students. The school has a staff of 96 teachers.

Organization and Human Involvement

Because of its emerging role as a pilot school for administrative and other uses of computers for the Toronto Board of Education, Danforth Technical School has received a great deal of administrative support and encouragement. The extent of the school's computer programs necessitated the establishment of planning and monitoring committees that involved the principal, vice-principal, and six key teachers from each of the six departments originally participating in the pilot project. These teachers examined a total of 500 computer programs, specified the programming for 25 programs, and tested 15 programs in their classrooms. The total number of teachers involved in using computers in the classroom increased from 35 at the beginning of the project to 60 today.

Initially, teachers obtained training through privately arranged and tailor-made courses at the local community college. As well, eight-hour introductory courses and 26-hour beginning programmer courses are currently offered to teachers. Sixty of the school's 96 teachers have taken a beginners' course in BASIC programming.

The first reactions of some departments (e.g., the English department) to the use of computers in the classroom were negative, but over time this changed. Today, more departments want to become involved than can be handled by the available resources. The main problems raised by teachers relate to an insufficient quantity of hardware and software and the need to develop skills that will enable teachers to maximize their use of computers.

Parents were invited to participate in the workings of the pilot study's advisory committee. They also played a modest role in reviewing software. Reactions to the project from the community were favourable. The only criticism was that there was not enough equipment in the school to take full advantage of the students' enthusiasm.

Because of the nature of the school, most students from Grades 9 to 13 have had some exposure to computers. For example, of the six departments involved initially, all have used computers in the classroom with at least half their classes, thus exposing most students to computer operations; the new Computer Applications, Programming, and Operations course is giving hands-on experience to 85 per cent of the 105 Grade 9 Advanced-level students. Beginning in 1983 the new computer literacy shop block will expose all of the 260 Grade 9 General-level students to computer use, and the new Advanced-level Industrial Control Systems Technology program will teach 50 students per year about computer interconnection, usage, and programming. The OISE video disk project on machining operations has trained more than 150 students on a hands-on basis in the past year and a half. The new Computer Technology program will teach 50 students per year about computer operations, functions, and programming; the computer programming courses in the mathematics department train 60 Grade 11 and 12 students each year to program in both FORTRAN and BASIC. As well, eight Advanced-level students have created about 25 programs and have modified more than 25 others.

Student reaction has been very positive. Students particularly enjoy the individual attention provided by computers and find working with the equipment interesting and fun. New courses and programs that utilize computer resources are being developed and will increase on a subject-by-subject basis as better software is developed and hardware supplies increase.

Equipment

Each of the six departments initially involved in the pilot project was equipped with the following hardware:

- 2 Commodore PET computers
- 1 disk drive
- 2 cassette tape recorders
- 1 printer

In addition, five of the six departments had at least one specialized piece of equipment:

- an Apple II plus a graphics tablet and Apple Pilot software for drafting
- an arbiter system plus Waterloo BASIC chips for mathematics
- a word-processor chip plus an arbiter system for special education
- a modem plus a Visicalc chip for physics
- a high-resolution screen (visible memory) for chemistry

The equipment was retained by each of the six departments as distributed and was not locked up in one room. This added to its accessibility.

Security and the repair and maintenance of equipment did not pose serious problems except in the case of one department, in which both the physical placement and the quality of supervision continue to be inadequate. It is suggested that where a room is equipped with many computers, each machine be bolted to the table on which it sits.

A shortage of quality software was noted. It is suggested that courseware sources provide users with a frame of reference on available lessonware and lessonware packages. No problems were reported with storing and

distributing software. It is suggested that indexing and cataloguing might best be achieved through the use of a computer-based system that provides a two- or three-line summary of each program and three or four different cross-references.

Software was developed by students as outlined in the previous section above.

Curriculum Uses

The six departments involved in the pilot project all had a high use of computer resources. These subject areas were chemistry, mathematics, special education, drafting, electronics, and physics. Computers were found to be particularly useful in remedial mathematics (Sheridan Micro Math and OISE Math), in simulation (Merlan Scientific Co. Physics Programs), and in word processing (used in special education). Computers were found to be least effective for high-resolution graphics presentations, for programs in which colour would be advantageous, and for programs involving complex sound patterns. As part of the pilot project, DTS tested and evaluated a total of 90 different programs.

Issues and Concerns

The following are some of the concerns reported:

-- The available software is generally of poor quality. Teacher and student documentation is lacking in most materials. (Most of the 90 programs evaluated in the project were modified for use in the school's program.)

-- The quantity of software available is insufficient.

-- The quantity of the computer equipment in the school is insufficient.

-- Much of the good available software is programmed for Apple computers. Although some of the key ideas from many of these programs are beginning to show up on PET programs, the process is very slow and unpredictable. Therefore, it would be useful if more Apples were available.

-- There is a need for record keeping to facilitate teacher support and control of student learning.

Conclusions and Recommendations

The following are some of the conclusions and recommendations contained in this report. They have been roughly grouped in the four areas outlined in the pilot project's terms of reference, which are quoted in the executive summary.

1. Effects of the Use of Computers in Schools on Students, Teachers, and the Community

-- The effects of the use of computers in schools on the community was generally positive. This is probably the result of the extensive public-relations procedures followed by the pilot schools, combined with parents' involvement in pilot project steering committees. It is recommended that boards and schools take steps to inform their communities of the progress in using computers in schools and encourage them to become involved.

-- Where in-service training is readily available, teachers have been generally positive about the use of computers. It is recommended that as much in-service as possible be provided to teachers by both boards and individual schools. Such in-service can be co-ordinated with course offerings at local community colleges, faculties of education, and schools. It can range from demonstrations and displays during professional activity days to informal and formal courses of varying lengths of time. In-service programs should take into consideration the particular needs of individual schools and should help teachers to relate the use of computers to the needs of the school curriculum and modify existing lessonware when required.

-- Many schools found that the amount of additional time involved in introducing computers into the classroom was

very high with respect to both administrative (secretarial) tasks and teaching duties. It is recommended that allowances be made, wherever possible, for the involvement of additional personnel during the initial stages of using computers in schools.

-- All of the pilot schools experienced an enthusiastic response from their students. The involvement of students in administrative, planning, and other activities added to this enthusiasm and encouraged in students a responsible, protective attitude, which helped to prevent vandalism and misuse of the equipment. It is therefore recommended that students be involved in as many ways as possible in a school's program for using computers.

-- Some system is required for measuring the effectiveness of using computers in the classroom. The ministry might consider developing such a system or set of criteria.

-- The question of whether the use of computers in the classroom will have a harmful effect on students' mastery of basic skills was raised repeatedly. The ministry might consider commissioning research into this area or, if such research already exists, providing schools with copies of the findings.

-- One of the reports from a pilot school raised the question of whether computers can have a harmful effect on students' health. Since this question is often raised by the media, it would be a good idea for the ministry to present the data regarding this issue to the public through the schools throughout the province.

-- In schools in which some teachers are resistant to using computers in the classroom, an unequal level of computer literacy may result. As well, students who develop computer literacy skills in one grade may find that they

no longer have opportunities to use computers when they proceed to a new class or grade. It is suggested that the board and the school administration take steps to avoid such problems by encouraging the use of computers through providing time and financial support for teachers to continue in-service training before, during, and after school.

-- Most of the pilot schools report that the amount of computer equipment available is insufficient to provide all students with equal and satisfactory access to computer resources.

-- Some problems were experienced in converting a standard classroom into a computer work area or lab. It was suggested that the ministry commission a research study on how best to do this.

-- In the construction of computer labs in elementary schools, some problems were experienced with furniture and equipment that did not meet students' physical requirements. These needs should be taken into consideration when equipping computer labs.

-- The indexing and cataloguing of software caused problems in some schools. It has been suggested that the ministry establish a computerized data management system so that software can be managed on a large scale, with the Universal Product Code centrally generated.

-- It was suggested that trustees are not sufficiently familiar with the use of computers in schools to see the need for budgetary support of this aspect of education. It was therefore suggested that more information and advice be supplied to them by the ministry and by trustee organizations.

-- There is a need to teach typing skills at an early age.

There is no clear-cut answer, however, as to exactly when this should happen or by what method these skills should be taught. The ministry might consider commissioning some research to resolve these questions.

2. Criteria for Quality Courseware and Hardware

-- Many of the pilot schools found cassette tape recorders inferior to disk drives because of the additional time they require. The delay caused frustration in students and dampened their enthusiasm. It is therefore recommended that when new purchases are made, disk drives be favoured over cassette tape recorders.

-- Computers with only 16K of memory were found to be inadequate for many of the programs currently being developed. It is suggested that computers with at least 32K of memory be considered when new purchases are being made.

-- Although not all of the pilot schools experienced difficulties with the cataloguing and indexing of software and courseware, this may become more of a problem as the number of available programs increases. Thus, the ministry should consider establishing a workable provincial system for cataloguing and indexing software.

-- Much existing software is not sufficiently tied to the curriculum and is not organized in sequential lesson units. The ministry might consider issuing these criteria for the development of new software, as well as for any official approval or listing that may eventually be given to computer software.

-- Since there is a great variety in the quality of existing software, the ministry should consider publishing a list of approved software that meet some

pre-set standard in the same way as textbooks are approved for listing in Circular 14.

-- Several schools reported a need for a regular maintenance program to be provided on a board-wide basis, either through an outside service contract or through trained board personnel. In this way, valuable equipment will not be lost to schools for extended periods of time.

-- It was frequently observed that much existing courseware does not provide the teacher or student with sufficient help. One suggestion that has been made is that the courseware have menu/help routines built in and adequate documentation.

3. Topics and Subjects That Lend Themselves to the Most Effective Use of Computers

-- Language and mathematics were generally reported to lend themselves to the most effective use of computers. There is also a great amount of lessonware available for drill and practice for language and math skills.

-- LOGO software was used in some pilot schools and provided extensive opportunity for students to develop logic and problem-solving skills.

-- Computers were found to be useful in improving the motivation of visually or kinesthetically oriented learners (especially where drill work was involved), and in extending students' attention span. Some additional research might be advantageously conducted in these areas.

4. Priorities for Future Courseware Development

-- The computer was generally found to have a limited use in social (history/geography) and environmental studies, music, modern languages, and art. Often this is because much of the existing courseware originates in the United States. It would be useful, therefore, for the ministry to explore ways of encouraging the development of effective software in these areas.

-- A need was expressed for programs that teach thinking and logic skills, which will ultimately equip students to use the computer as an effective tool. The ministry might beneficially explore this further.

-- There is a profound need for courseware in the French language. This should be given a high priority by the ministry.